An Ecological View of a Subsistence Economy Based Mainly on the Production of Rice in Swiddens and in Irrigated Fields in a Hilly Region of Northern Thailand

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Abstract

Some aspects of the subsistence economy of a Skaw Karen tribal village, based mainly on rice production in swiddens and in wet fields in a hilly region of Northern Thailand, were quantitatively investigated. The labor productivity at swiddens in terms of energy, that is, the ratio between the combustion energy of husked rice from swiddens and net energy expenditure of a worker, was calculated to be not more than 14.5 which was estimated to be far less than that at wet paddy fields without the input of compost and chemical fertilizer. In normal years, approximately 45 percent of the total annual rice production in this village is surplus, above the base subsistence level (domestic consumption plus reserve for seeds). Roughly 40 percent of this surplus is consumed by the herd of pigs in the village. The amount for sale is not very great in terms of the percentage to the total rice production of the village. A consideration using a simple model elucidated that the rice production at swiddens alone can hardly provide the surplus above the base subsistence level. The huge surplus which this village produces results chiefly from the rice production in wet fields. For a swiddener, cultivation of a wet field hardly reduces the production at his swidden, but adds to the yield of his swidden. Furthermore, the management of wet paddy fields improves the average labor productivity of a swiddener. For religious reasons, the villagers are obliged to keep a large herd of pigs. Their desire to multiply the number of pigs is very great and not yet satisfied. The herd seems to fill the role of shock absorber against a bad harvest. Although the calory and protein intake of the inhabitants derives mostly from rice, the nutritional state there is not considered to be very poor.

Introduction

This report, which follows an earlier one [Nakano 1978], is mainly concerned with some aspects of the subsistence economy of a Skaw Karen tribal village in the hills of Northern Thailand. It is based on the field research which I conducted over 21 months from August 1972 through April 1974. The inhabitants of this Skaw Karen tribe village, the *ban* (village) of Mae Tho Yang, manage both wet paddy fields and swiddens every year. The

* Some of the data in this paper were presented at the Memorial Meeting for the 50th Anniversary of The Association of Japanese Geographers, May, 1975. However, partial rectification was made for this paper.

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viewpoint of this study is ecological and partly in line with that of Walker [1976] or Kunstadter [1978], both of whom also deal with the hilly regions in Northern Thailand. However, it is expected that the quantitative data demonstrated below will be helpful for further deepening our fundamental knowledge of one type of rural economy in Southeast Asia.

In this investigation, little emphasis is placed on the sociology or cultural anthropology of the traditional life of Skaw Karen tribe. This has already been exhaustively treated by Iijima [1971]. And the location and physical background of the village have been described in the preceding report [Nakano 1978].

Population and Households of the Village

Table 1 shows the result of the demographic investigation of my survey village. At the end of 1973, this village totaled 183 persons (99 males and 84 females) and 28 households. As for family size, the mode is five and the median, mean and standard deviation are calculated to be 6.00, 6.54 and 2.83, respectively. Because the villagers themselves did not correctly know their own ages and the objective determination of their ages was very difficult, only six age categories are here distinguished considering the changes of the ability as an agricultural worker

Table 1 Population and Households of Mae Tho Yang Village at the End of 1973

House number	Total family size	Family composition								Remarks
		Sex	Age category							
			0–4	5–9	10–14	15–24	25–49	50+	Total	
1	11	Male	1	2	2	2	1		8	Nuclear family.
		Female			*1*	*1*	*1*		*3*	
2	13	Male	2	2	1	3	1*+1		10	Two couples and three generations.
		Female				*2*	*1*		*3*	*Village headman.
3	10	Male				4	1	1	6	Three couples and three generations.
		Female				*2*	*1*	*1*	*4*	
4	4	Male					1	1	2	Three generations.
		Female		*1*			*1*		*2*	
5	5	Male	1				1	1	3	Two couples and three generations.
		Female					*1*	*1*	*2*	
6	8	Male				2	1		3	The mother of the husband, her son and daughter lived in the household.
		Female			*1*	*2*	*1*	*1*	*5*	
7	9	Male			2	1		1	4	Nuclear family.
		Female			*1*	*3*		*1*	*5*	
8	5	Male	1				1		2	Nuclear family.
		Female	*1*	*1*			*1*		*3*	
9	8	Male		2	2				4	Husband dead. His two surviving wives (Lua' tribe women) lived together.
		Female			*1*	*1*	*1*	*1*	*4*	
10	7	Male				2		1	3	Nuclear family.
		Female			*1*	*2*	*1*		*4*	

Table 1 (continued)

11	3	Male				1		1	2	Two couples and three generations until Sept., 1973. See House no. 28. Nuclear family after the separation.
		Female					*1*		*1*	
12	6	Male	1				1		2	Nuclear family.
		Female	*2*	*1*			*1*		*4*	
13	6	Male	1				1		2	Nuclear family.
		Female	*1*	*2*			*1*		*4*	
14	4	Male	2				1		3	Nuclear family.
		Female					*1*		*1*	
15	5	Male					1		1	Nuclear family.
		Female	*1*	*1*		*1*	*1*		*4*	
16	11	Male	2		2	2	1		7	One woman was a sister of the wife and unable to work.
		Female	*1*			*1*	*2*		*4*	
17	3	Male					1		1	Nuclear family.
		Female	*1*				*1*		*2*	
18	4	Male					1		1	The mother of the wife lived in the household.
		Female	*1*				*1*	*1*	*3*	
19	3	Male					1	1	2	It was uncertain whether the old man was the father of the husband or the wife. The old man was the religious leader of this village.
		Female					*1*		*1*	
20	5	Male	1	2			1		4	Nuclear family.
		Female					*1*		*1*	
21	10	Male	1	1	1	1	1		5	Nuclear family.
		Female		*1*	*2*	*1*	*1*		*5*	
22	4	Male	2				1		3	Nuclear family.
		Female					*1*		*1*	
23	6	Male		1		1	1		3	Nuclear family.
		Female			*1*	*1*	*1*		*3*	
24	11	Male	1	2	2	1	1	1	8	The father of the husband lived in the household.
		Female			*1*	*1*	*1*		*3*	
25	5	Male					1	1	2	Two couples and three generations.
		Female	*1*				*1*	*1*	*3*	
26	7	Male	2				1		3	Nuclear family.
		Female	*1*	*1*	*1*		*1*		*4*	
27	3	Male					1		1	Wife dead.
		Female		*2*					*2*	
28	7	Male	1	2			1		4	This household separated from House no. 11 in Sept., 1973. Nuclear family.
		Female	*1*	*1*			*1*		*3*	
Total	183	Male	19	14	12	20	25	9	99	
		Female	*11*	*11*	*10*	*18*	*27*	*7*	*84*	
		Total	30	25	22	38	52	16	183	

Notes: Three Thai male teachers at the primary school in the village are not included in this table. Two teachers belonged to the age category 25–49 and the other to that of 15–24. They usually lived at this village.

Mean family size = 6.54　Median family size = 6　Standard deviation = 2.83

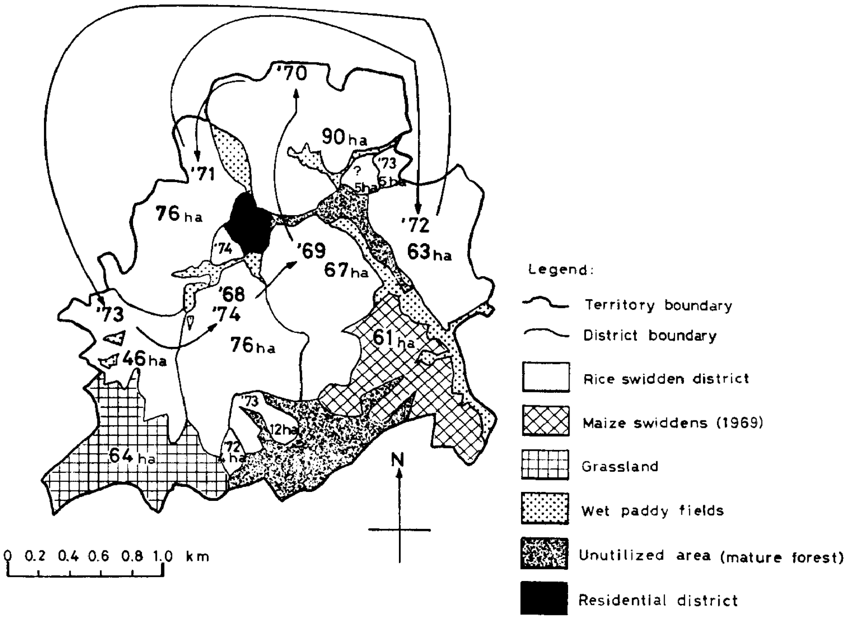
and food demand in accordance with ages. If their working ages are here defined as those between 15 and 49 years of age, the ratio of working population to the total at this village is calculated to be about 50 percent. Furthermore, the people of the two age groups, 10–14 and above 49, are of considerable use to the labor force there. Although the sex ratio of the age group 0–4 appears to be abnormally unbalanced (Table 1), the null hypothesis ($p_0 = 0.5$) cannot be rejected at the five percent level.

Population growth was evident although the number of couples of reproductive ages did not increase during the survey period. In 1973, the net increase of population was one person, while it was two persons during the first four months of 1974. Similarly, the number of households was also gradually increasing. They reported that it had been about 20 in the earlier years of 1960s and 25 in 1969.

Approximately 60 percent of 28 households comprised a married couple and its child or children. Most people find their spouses within the village. Only a very few couples had contracted intervillage marriages. Several young men had worked in urban areas such as Chiang Mai, Mae Sariang. The second son of the village headman (House no. 2 in Table 1) and another young man were permanently hired by the Station of Royal Forest Department at Mae Sariang. Similarly, two sons of House no. 10 and another young man had been working for a factory in Chiang Mai since a few years before. Those emigrants are, of course, not counted in the actual population shown in Table 1. No one went out of the village to seek a temporary job in the off-seasons of agricultural activities while I was there.

Land Use and Tenure Systems

The general features of the land-use pattern of this village are explained in my earlier paper [Nakano 1978: 416–418]. More detailed information concerning village land use is given in the Land-use Map below, where the district boundaries depicted in Map 2 of the preceding paper [Nakano 1978: 413] are more accurately drawn and the estimated values of the areas of respective swidden districts are shown. For the estimation of the shown values which take the circumstances of actual slopes into account to some degree, a three-dimensional topographic model was utilized. Moreover, this map was made up on the basis of an aerial photograph (1: 20,000) and various other sources of information. The total area of the whole territory of this village is estimated to be approximately 600 hectares (ha) according to the map alone, while the surface area is increased to 670 ha when the correction by means of the above-mentioned model has been made. Hence the population density there is calculated to be 27.3 persons per square kilometer. The total area of the districts of irrigated paddy fields is estimated to be 37 ha from the Land-use Map. When we take account of the fact that paddy is not planted in the peripheral zones of



Land-use Map Land-use pattern in Mae Tho Yang Village. The areas shown above are surface areas which take the features of hills into account. In reference to the topographic features of this village, see Map 2 in the preceding paper [Nakano 1978].

those districts and on the dikes, however, the total area actually available to the villagers for rice production should be regarded as a little more than 30 ha. In this paper, it is tentatively estimated at 31 ha.

Table 2 shows the estimated areas of the districts which were utilized for swidden farming at the village each year from 1969 until 1974. On average, more than 70 ha of secondary forest were utilized annually as rice swiddens during this period. However, the areas actually available for rice production in the swidden districts should be somewhat reduced, as in the case of wet paddy fields, since the basal areas of many big trees in the swiddens and the areas of peripheral zones of those districts have to be excluded. Unfortunately, it is impossible to estimate accurately the areas unavailable for rice production in the respective swidden districts. Nonetheless, it is tentatively assumed here that 90 percent of those areas shown in Table 2 can actually

Table 2 Total Area of Rice Swiddens at Mae Tho Yang Village in Each Year from 1969 through 1974

Calendar year	Area of rice swiddens ha
1969	67
1970	90*
1971	76**
1972	67
1973	63
1974	76
Mean	73.2

Note: These swidden areas include the plots unavailable for actual production. In this paper, the areas in production are assumed to be 90 percent of these values.

* Some swiddens for maize and/or opium production may have been included.

** A swidden was used for opium production.

be utilized for rice production. In 1973, one or two swiddens were made exceptionally at a peripheral zone of the mature forest on the top of a hill.

In 1969, the villagers made maize swiddens besides rice ones for the purpose of urgently re-establishing their herd of pigs, which had mostly died of a contagious disease in, perhaps, 1968. They claimed that the maize harvest there had been poor. It may be that they used to utilize this district of maize swiddens for rice production every several years. According to the village headman, a rice swidden was utilized every seven or eight years in olden days. To sum up, roughly 80 percent of the area of their territory is actually utilized for the production of cereals.

The land tenure system of Karen people in this region is stated by Kunstadter [1978: 80]. My survey village does not seem to be exceptional. The rule of private ownership is strictly applied to wet paddy fields. However, in the cases of swiddens, some aspects of communal land ownership seem to remain. Nevertheless, as a rule, each household has a definite area for swidden in every district. The areas of swiddens which a family holds fluctuate year by year. For example, the household of the village headman (House no. 2 in Table 1) managed more than four ha of swidden in 1973, but only about three ha in 1974. Most households, except four families (House nos. 7, 9, 15 and 17), manage their own wet paddy fields. The village headman owns more than two ha of wet fields and, perhaps, holds the largest share of wet paddy fields at the village. The couple of House no. 12 were both young and had no share in the swidden district of 1972. However, they cleared a piece of land in the mature forest near the top of a peak (unutilized area to the south of the residential area) in 1973.

Labor Input

The technologies at a rice swidden and an irrigated paddy field in this region are described in Kunstadter [1978: 81–100]. Therefore, they are mentioned partially here in relation to the labor calendar and input of the villagers. At irrigated fields, the people use plows with the help of carabao power for cultivation and use neither compost nor chemical fertilizer. No family of this village adopts the early ripening varieties of rice. Both at swiddens and at wet fields, it takes roughly six months after seed germination before their paddy is ready to be reaped.

Table 3 briefly shows the annual cycle of the agricultural activities of the inhabitants other than the school teachers. In this table, it should be remarked that the distribution of labor input is carefully planned so that the days for work in irrigated fields and in swiddens may not fall at the same time, except in June. Before transplanting rice seedlings to irrigated fields, they usually do not use wet nurseries but only dry ones, due probably to the consideration of labor input. At irrigated fields, as Kunstadter [1978: 93] states, "Once the fields are transplanted, relatively little work re-

Table 3 Annual Cycle of the Agricultural Activities at Mae Tho Yang Village

Climatic season	Month	Swidden activities	Irrigated field activities
Cold and dry	January		
Warm and dry	February	Clear swiddens.	
Hot and dry	March	Dry slash (no labor input). ←Burn fields.	
Hottest and dry	April	Prepare fields.	
Rains begin	May	Plant rice and minor crops.	Repair dikes. Begin inundation of fields.
Hot and rainy	June	First weeding.	Plow fields. Sow dry nursery.
	July		Transplant rice seedlings. Control water level.
	August	Second weeding. Harvest of maize.	
Heavy rains	September		Weed and make repairs as necessary.
	October		
Rains stop	November	Harvest of rice, sorghum, taro and cucumber.	Harvest.
Cool and dry	December		

mains until harvest." Weeding is sporadic and not intensive there.

As for swidden farming, the labor efficiencies of clearing forests, sowing, weeding and the activities for rice harvest were actually estimated in terms of square meters (m^2) per man-hour. The labor efficiency of burning in terms of this unit is meaningless. At the time of actual measurement, the researcher must take care that workers do not notice they are under examination [Walker, 1973, personal communication]. In order to solve this difficulty, the following procedures on the principle of Monte Carlo method for the estimation of an area were adopted for the estimation of labor efficiencies:

1) Slashing and felling vegetation. The number of trees cut down during a period of time was recorded as the first step. At that time, the trees whose diameters at the cuts were less than five centimeters (cm) were not counted. After the first step, the number of cut trees with the cuts of more than or equal to five cm diameter in a definite area were counted. By

combining these two sets of data, the labor efficiency of a person at the time of clearing a forest can be calculated.

2) Sowing rice seeds. This operation is carried out co-operatively, as is described by Kunstadter [1978: 86–87]. As for the persons who dibbled holes in the earth, the number of shallow holes made by one person during a period of time was counted as the first step. Subsequently, the number of holes made by him in a definite area was counted. Concerning the rice sowers, the number of holes into which a person dropped seeds during a period of time was recorded. A shallow hole is covered with nothing.

3) Weeding. The swiddeners put a bundle of weed on the earth when the bundle has become too large to be grasped. Thus, at a plot where they have finished weeding, the bundles of weed are randomly distributed. There is no bamboo shoot at their swiddens. To measure labor efficiency, these bundles of weed scattered at a swidden were counted. The principle of this estimation method is similar to the method mentioned above in respect to clearing forests. During the second weeding, the villagers very often perform collectively this tedious operation and, consequently, they clear the weeds in a roughly rectangular area between their rest times. This means that measuring the efficiency of a person was impossible in such cases.

4) Reaping paddy. The number of sickle strokes for reaping paddy during a period was counted. It was easy to estimate how many strokes were needed for reaping the paddy in a definite area of land because the arrangement of the clumps of rice plants is quite regular and a clump of them is cut at one stroke of the sickle. After reaping, the swiddeners make the bundles of paddy and put them on the earth; they do not stack paddy.

5) Threshing. In this case, the division of labor is distinct. There are two roles for this operation, namely, the persons who carry the bundles of paddy to the threshing site and those who actually thresh and winnow paddy. So that, the values of labor efficiencies indicate the areas from which the bundles of dried paddy have been taken away per participant-hour. The estimation of such areas was not easy. The total quantity of unhusked rice having been threshed during a period was divided by the average yield of rice per unit area at the respective swiddens for measurement. According to this calculation method, the areas of the parts unavailable for rice production are excluded from the actual area from which paddy bundles have been taken away, because the measurement of rice yield per unit area was made at the test-plots which had no parts unavailable for rice production.

At the time of measurement of labor efficiencies, a rest time for more than 15 seconds was excluded from the work time. However, a time of the necessary movement for continuing an operation was included in the work time. With respect to threshing, inasmuch as personal measurement was impossible, only the rest times of a team as a whole were excluded from the work time. When the swiddeners collectively perform weeding in August and September, no one usually takes personal rest times for more than 15 seconds before a rest time of the team. All the data except for the cases of collective operation were obtained from adult people of ages 15–49. The results of quantitative investigation are displayed in Table 4. All of these data were obtained at the swiddens from secondary forests.

For burning the slashed and felled vegetation, nearly 30 persons including a few active women participated in the operation. On March 31, 1973, at three upper spots of the slopes of a district (much more than 40 ha), where the swiddens of 20 households were contained, they ignited fire at 12: 30 and all the inflammable things there burned out at 14: 00. However, many charred logs lay there after the fire. The swiddeners at Mae Tho Yang Village do not re-burn such debris. They utilize those charred logs for marking the boundaries of their

Table 4 Quantitative Data of Labor Efficiencies of the Activities for Rice Production at Swiddens of Mae Tho Yang Village

Activities		Number of actually measured cases	Mean m^2/(man·hour)	Range m^2/(man·hour)	Remarks
Slashing and felling vegetation		Men; 5	190	92–267	These measured cases do not include ones in which big trees were not felled but only the branches and twigs of those trees were cut off. Therefore, the mean value for men may be overestimated.
		Women; 9	174	126–250	
		Total; 14	179	92–267	
Sowing	Stick-holder	Men; 6	453	284–630	Sowers (women) closely follow stick-holders (men). Sowing the swidden of a household is a communal activity. At least one person from each household in the village must participate.
	Sower	Women; 5	446	360–526	
First weeding		Man; 1	67		Usually, men are engaged in the cultivation of wet fields and rarely work in the swiddens in this season.
		Women; 13	73	31–109	
		Total; 14	73	31–109	
Second weeding		Man; 1	25		Men rarely engage individually in weeding. The teams for measurement were composed of 8 and 13 persons, respectively.
		Women; 4	31	23– 41	
		Team; 2	22	21– 22	
Harvest	Reaper	Men; 3	66	49– 83	The teams for measurement were composed of 7, 9 and 11 persons, respectively. The operation of threshing here includes winnowing.
		Women; 4	53	36– 70	
		Total; 7	58	36– 83	
	Carrier and thresher	Team; 3	55	37– 85	

swiddens, fencing the whole district of those swiddens and building their field huts. Both fencing a district and building a hut are not very laborious. For an adult man, the former requires a few days' labor input, whereas the latter needs a half-day's input. Fencing their swiddens can be efficiently carried out due to a situation peculiar to their case, since their swiddens collectively lie side by side and, in consequence, the total length of the fence is far less in comparison with another imaginable case in which the same number of swiddens, corresponding to theirs in size, lie isolatedly.

In Conklin's data [1957: 150] with regard to labor input at a swidden, many man-hours are expended on watching and guarding. However, the swiddeners at my survey village do not seem to pay so much attention to watching and guarding as those with whom he dealt. The Karen swiddeners do not build a watchtower. Of course, they watch for bird pests and frantically drive their livestock away when a carabao enters their swiddens. One or a few young men of a family sleep at their field hut for the night to guard their rice when it has been threshed at the swidden. However, the estimation of such activities in terms of man-hour values is extremely difficult. According to the data of Walker [1976: 181] concerning Northern Thailand, he estimates the labor input of such activities to be more than 20 man-days per household-year on average. This value is roughly half as much as the man-day value of reaping and stacking the main rice crop. Yet, usually, such activities do not require much extra energy. So that, when labor input is converted into energetic terms, the operation of watching and guarding may be omitted from the count of labor input for rice production at a swidden if one comprehends that the following discussions are based on such circumstances and, in consequence, that the total labor input per ha-year shown below is somewhat underestimated.

Because discussions are here limited to the labor input at a swidden, the energy expenditure for transportation of threshed rice is not taken into consideration as well as the investigation by Conklin [1957: 150].

At any rate, the operation of the worst efficiency is certainly the second weeding in August and September. Although the amount of data is not really sufficient, Table 4 suggests that, for this operation, making a team does not necessarily improve labor efficiency. As is stated by Kunstadter [1978: 91], concerning a land-use system similar to that of my survey village, the upper limit of the manageable area of a rice swidden in this region is probably determined by the efficiency of weeding in the middle of rainy season. In this season, weeding of the swiddens has to be completed within one and a half months because if it took longer, weeds would surpass the rice plants in height and cause a bad harvest. But the villagers cannot work without some holidays. Therefore, the number of days when they are actually engaged in weeding at a swidden in the middle of the rainy season is estimated at 40. When these circumstances are taken into account, from the mean values in Table 4, the upper limit of the manageable area of a rice swidden in this region is concluded to be slightly more than 0.6 ha per worker of an age between 15 and 49 on the assumption that a swiddener actually works, for the operation of weeding, at the rate of 7 hours a day on average excluding his rest times. In fact, inasmuch as the people of the two age groups 10–14 and above 49 help the main workers, the maximum value of the manageable area can be considered to be somewhat more than 0.7 ha per worker of an age between 15 and 49 on average. It has to be remembered that these estimated values exclude the area of the parts of a swidden that are unavailable for rice production.

In the real case, in 1973, the average area per main worker of the village can be calculated to be 0.64 ha from Table 1 and Table 2 (including its footnote). This value is less than the foregoing maximum manageable area. For that year, however, the villagers could not prepare an average area for rice swiddens owing partly to alleged conflicts with Meo tribespeople in 1966 and the following years [Nakano 1978: 418]. As can be calculated using Table 2, in ordinary years, they prepare approximately 70 ha of rice swiddens, of which nearly 65 ha is assumed to be actually available for rice production. Thus, it is concluded that a main worker at my survey village manages about 0.7 ha of rice swidden with the help of his children and/or old people in an average year. This conclusion implies that the villagers prepare, in most years, almost the maximum area of rice swiddens they can manage in the usual mode of labor input. In 1969, they planted another district to maize in addition to rice cropping, as shown in my Land-use Map. In this case, their mode of labor input is not considered to have changed very much, since maize plants grow rapidly at the early growing stage and can compete with weeds to some degree without the help of human activities. The reason why they had a poor maize harvest in that year can be conceived to be that they could not intensively take care of the maize plants.

In 1970, however, they are considered to have managed, on average, areas exceeding the above-mentioned maximum although some swiddens may have been utilized for maize and/or opium production. It may be that they worked exceptionally hard or they had a low rice yield per area in that year. Certainly, both labor efficiency and input depend on and are adaptable to circumstances to some extent. Nevertheless, it is very difficult to conceive a case that a main worker at a Karen or Lua' village in Northern Thailand is able to manage more than one ha of rice swidden with the help of his children and/or old people.

From Table 4, the total labor input needed for rice production in a one-hectare swidden of my survey village can be estimated. That is, 56 man-hours for slashing and felling vegetation, 45 man-hours for sowing, 137 man-hours for first weeding, 417 man-hours for second weeding and 354 man-hours for harvesting. These add up to 1009 man-hours per hectare for a year. However, due to farming activities other than those shown in Table 4, this total value may be considered to be somewhat underestimated. If we assume that a farmer actually works on rice production at a swidden, on average, for six hours (excluding rest times) on a working day, 1009 man-hours corresponds to 168 man-days. Considering the farming activities which are omitted from Table 4, this result is fairly similar to that of Walker [1976: 180] who estimates the labor input for rice production at a swidden to be 178 man-days per hectare for a year. Let us review other well-known data obtained in Southeast Asia. On the one hand, according to Conklin [1957: 150], much more labor input than 1009 man-hours for rice production is evaluated at the swiddens derived from secondary forests in the southeastern part of Mindoro Island, even if the man-hour values of fencing, protection and guarding are not taken into account. On the other hand, Freeman [1970: 245], who deals with farming activities similar to those in Table 4 of this paper, estimates the corresponding value at 125–165 man-days (including the labor input for transporting the harvested rice) per hectare concerning the swiddens in Sarawak.

Recently, some researchers, for instance, Rappaport [1971], have attempted to present the labor input in agricultural systems of the tropics in terms of energetic units such as kilocalorie (kcal), megajoule. Norman [1978] reviews those data and discusses some fresh problems brought forward by such an approach. At any rate, from the viewpoint of science, it is desirable to convert man-hour data into values in terms of expended energy. But fundamental and reliable data are lacking for scientific examination. Tentatively, because Norman's assumptions [1978: 356] seem fairly reasonable, they are here adopted as follows:

Basal metabolic energy expenditure	60 kcal/hour,
Gross work energy expenditure	240 kcal/hour,
Net work energy expenditure	180 kcal/hour.

In the future, the man-hour data in this paper will be more accurately converted into work energy expenditure by means of more precisely examined values. At the time of future amendment, it must not be forgotten that the rest times above 15 seconds are excluded from the respective man-hour values in this paper.

As has been already stated, the total labor input for the essential activities of rice production at the swiddens of my survey village is estimated at approximately 1000 man-hours per hectare for an agricultural year. In addition to the essential activities shown in Table 4, the labor input for burning (though this activity is not subsidiary, but the most essential for swidden farming), clearing

Table 5 Quantitative Data of Work Energy Expenditure for the Essential Farming Activities of Rice Production in the Swiddens of Mae Tho Yang Village

Activities		Gross work energy expenditure kcal/(ha·year)	Net work energy expenditure kcal/(ha·year)	Remarks
Slashing and felling vegetation		13.4×10^3	10.1×10^3	These values may be slightly underestimated.
Sowing	Stick-holder	5.3×10^3	4.0×10^3	
	Sower	5.4×10^3	4.0×10^3	
First weeding		32.9×10^3	24.7×10^3	
Second weeding		100.1×10^3	75.1×10^3	
Harvest	Reaper	41.4×10^3	31.0×10^3	
	Carrier and thresher	43.6×10^3	32.7×10^3	
Temporary total*		242.1×10^3	181.6×10^3	These values may be slightly underestimated.

Note: For the computation of these values, Table 4 and Norman's assumptions [1978: 356] were combined.

* Other Swidden activities besides those shown above have to be taken into account. See the text for details.

debris after burn, fencing, building field huts, watching and guarding has to be taken into consideration. As has been already discussed, the work energy expenditure for watching and guarding might be ignored. Thus, total man-hour value per hectare for the production of dry rice is considered to be nearly 1100 man-hours per hectare at the village for an agricultural year. When this value is combined with those above-mentioned values[1)] of energy expenditure per hour, the gross and the net work energy expenditures for the rice production at swiddens are respectively computed to be 2.6×10^5 kcal and 2.0×10^5 kcal. Table 5 gives the respective estimates of energy expenditure for essential farming activities of rice production at swiddens on the basis of Table 4. Because rest times of longer duration were excluded at the time of actual measurement for man-hour data, the possibility of underestimation in respect to those values in Table 5 cannot be ruled out.

1) Gross and net energy expenditures of 240 and 180 kcal/man-hour, respectively.

As regards the labor input for the production of subsidiary crops, no quantitative data were obtained. Of these crops, maize is probably the most important with respect to total yield. In usual years, maize seeds are sown at rice swiddens before or at the same time as sowing rice. The mode of sowing maize seeds is a little different from that of sowing rice. Attached to the end of a shorter stick, the steel blade used for making holes where one or two maize seeds will be dropped, is wider than the steel blade used for making holes for rice. For maize, a comparatively deep hole is covered with soil by hand after a seed or seeds have been dropped. The planting density of maize is much sparser than that of rice. Maize seeds are planted between the shallow holes made for rice. Maize ripens earlier than rice. Weeding specifically for the purpose of growing maize does not take place. For taro or cucumber, whose seeds are sown later than the time of sowing rice, the situation is similar to that of maize. However, the planting density is even sparser. Both crops are harvested at almost the same time as the harvest season of rice. Cucumber slakes the thirst of the farmers who are harvesting rice. A swamp plot (far less than one are) was utilized specifically for taro production in 1973. Sorghum is planted along the boundaries of swiddens as markers. An officer of the Tribal Research Center in Chiang Mai supplied a small quantity of soybean seeds for some leading villagers in 1973. They sowed those seeds at the peripheral zones of their swiddens. In a few months, however, most of the seedlings disappeared due to lack of care, and there was virtually no harvest of soybeans in 1973. At any rate, the quantitative data of labor input for rice production tell nearly the whole story of the labor input at swiddens of my survey village in usual years.

Production and Consumption

The rice production at my survey village in 1973 was estimated. For the estimation, paddy at some test plots (10 m × 10 m each) in both swiddens and irrigated fields was reaped. Swidden test plots contained no big tree which had not been felled. As can be expected, the rice yield per hectare at swiddens had much wider range than that at irrigated fields. The results of actual yield measurement are shown by Table 6. Data of

Table 6 Rice Yield in Irrigated Fields and Swiddens of Mae Tho Yang Village in 1973

	Number of test plots (10 m × 10 m each)	Mean estimated yield of unhusked rice in test plots
Irrigated fields	6	1.55 m. ton/ha
Swiddens	7	1.16 m. ton/ha

the rice yield (per hectare) at swiddens have been collected by other researchers. Compared with Walker's table [1976: 182], the value in Table 6 suggests a rather lower level than most others having been obtained in Southeast Asia. However, it is not worse than the figures obtained by Kunstadter [1978: 111]. In that year, the villagers of my survey were satisfied with a plenteous rice yield at both swiddens and irrigated fields. When the data in Table 6 are combined with the above-estimated areas (actually available for rice production) of swiddens and irrigated fields, the total rice production there in 1973 can be estimated to be 66 metric tons at swiddens and 48 metric tons at irrigated fields, respectively. In that year, the area of swiddens was less than that of an average year by more than 10 percent, whereas the yield was satisfactorily better than usual. Therefore, in usual years, the villagers seem to obtain 65–70 metric tons and somewhat over 40 metric tons of unhusked rice from swiddens and irrigated fields, respectively. Thus, the sum total of the unhusked rice having been produced there in 1973 is estimated at 114 metric tons which are considered to be more than the tonnage of usual years by several metric tons. This quantity of unhusked rice could have been converted into 84 metric tons of husked rice using the husking mills there.

On the other hand, it is notoriously difficult to obtain a reliable estimate of domestic rice consumption. Nevertheless, an attempt to estimate the rice consumption at my survey village was made. The method of estimation was similar to that adopted by Walker [1976: 182]. Consequently, a male adult is estimated to require, on average, 0.85 kilogram (kg) of husked rice daily. This quantity of husked rice corresponds to 1.15 kg of unhusked rice. Thus, at my survey village, a male adult is estimated to consume annually approximately 310 kg or 420 kg of husked or unhusked rice, respectively. From these data and Table 1, the estimate of the total domestic consumption of the whole village can be obtained if the International Scale of Man Units [Hinton 1969: xiv] is adapted in accordance with the age groups in Table 1 as follows:

Age in years	Male	Female
0– 4	0.25	0.25
5– 9	0.50	0.50
10–14	0.75	0.75
15–49	1.00	0.80
50+	0.90	0.80

Computation resulted in 41 metric tons (husked rice) or 55 metric tons (unhusked rice) per year. This indicates that average rice (unhusked) consumption per capita at the village is evaluated to be 300 kg annually.

As the next step, visible cost, namely, the demand for rice seeds, has to be estimated. Concerning swiddens, estimation was easy, since the number of seeds dropped at a definite area could be counted without difficulty at the time of sowing. Thousand-seed-weight was actually measured as well. However, similar methods could not be applied to the estimation of the seed quantity for wet fields because the farmers sow their nurseries (for the paddy at wet fields) so densely that the number of broadcast seeds at a definite area cannot be counted. Therefore, the second best method was adopted with respect to irrigated fields. That is, I asked the farmers how many *tangs*[2)] of seed had been broadcast. Most families have a few baskets whose volume is approximately one or half a *tang*. The seeds for swiddens and those for inundated fields are not interchangeable. As a result of computation, the swiddens and wet field nurseries of the whole village are estimated to have been sown with 5.3 and 2.7 metric tons, respectively, of unhusked rice in 1973. Thus, in that year, eight metric tons of unhusked rice is considered to have been used for the visible cost. In 1974, nine metric tons of unhusked rice is estimated to have been invested for the

2) One *tang*=20 liters

harvest of the year at the whole village. A sower drops, on average, as many as 33.5 seeds into a shallow hole at a swidden. On the basis of the foregoing data, the seed productivities at the swiddens and the irrigated fields of my survey village in 1973 can be calculated to be 12.5 and 17.8, respectively. Of these two figures, on account of the above-mentioned difference of the methods for estimation, the former is more reliable than the latter. Moreover, it should be remembered that both irrigated fields and swiddens yielded well at a definite area in that year.

Considering the balance sheet of rice between production and base consumption plus visible cost, the conclusion that my survey village, as a whole, runs short of the inhabitants' staple food a few months before harvest cannot be drawn theoretically from the relevant data above figured. For example, if we take the quantity of rice produced there in 1973

Table 7 Census of Pigs, Cattle and Carabaos at Mae Tho Yang Village in April, 1973

House no.	Pig (head)	Cow (head)	Carabao (head)	Remarks
1	10	12	4	
2	15	0	14	
3	5	0	4	
4	not available	0	3	
5	not available	0	not available	
6	3	0	not available	Two elephants.
7	5	13	0	No wet field is owned.
8	not available	0	2	
9	7	2	0	No wet field is owned.
10	10	0	6	
11	6	0	12	
12	1	0	0	
13	2	0	1	
14	not available	0	not available	
15	1	0	1	No wet field is owned.
16	3	0	2	
17	1	0	5	No wet field is owned.
18	5	0	3	
19	2	0	0	
20	3	0	1	
21	6	0	4	
22	2	0	0	
23	2	0	3	
24	3	2	5	
25	6	0	2	
26	4	0	8	
27	0	0	1	
Total	more than 102	29	more than 81	Three elephants.*
Mean±S.D.	4.43±3.54	1.07±3.28	3.38±3.66	

Note: Unweaned animals are not counted. House no. 28 separated from House no. 11 after this census.

* An unidentified family, possibly that of the village headman (House no. 2), owned one elephant.

and subtract annual base consumption and the quantity of seeds required for sowing in 1974, we obtain a figure of 50 metric tons surplus of unhusked rice. This value of surplus above the base subsistence level is nearly equal to the annual base consumption of the village. The villagers also grow glutinous rice at swiddens for a few special occasions in a year, but the production is not great. At a swidden, the area for glutinous rice is at most 0.05 ha. Its yield at a definite area appears to be less than that of ordinary rice. The school teachers usually buy rice at the Chinese shops of Mae Tho Meo Village which is one km distant from my survey village.

No quantitative data of production and consumption concerning the subsidiary crops at the village were obtained. Maize is mainly utilized as the feed of pigs and the raw material of liquor. At the residential district, some herbs including seasoning plants and chili, banana, cassava, shaddock and tobacco are grown. However, their yields seem to be trifling except for a few seasoning plants, including chili, and the leaves of banana which pigs are willing to eat. In some years, the villagers grow opium poppies at a swidden for their own consumption, as stated in Nakano [1978]. When this field research was made, approximately 20 of the inhabitants were opium addicts.

Next to rice production, animal husbandry is important for the economy of my survey village. Dogs, cats, chickens, pigs, cattle and carabaos are raised there. Furthermore, elephants are kept. As regards the technology of animal husbandry, the description by Kunstadter [1978: 100–105] is available. Table 7 gives the census of pigs, cattle and carabaos, though incomplete, at the village in April 1973. I did not count chickens there, for their number fluctuated greatly. In respect to the animals in Table 7, unweaned ones were not counted. Table 7 provides interesting information when it is combined with Table 1. Pigs and carabaos are raised by most families, whereas cows are owned by only a few families. Of course, chickens are kept by all the families. It should be remarked that even the two families (House nos. 15 and 17) which manage no irrigated field own carabaos. This is because they intend to obtain cash income through selling carabaos which have grown up. Thus, owning many carabaos is considered to be positively correlated with cash income. The figure in the following page has been made from Tables 1 and 7. This shows the correlation between the number of household members above nine years of age and that of pigs of the household. The value of correlation coefficient (r_1) is 0.61, which is highly significant. Similarly, the correlation coefficient (r_2) with regard to the number of carabaos plus cows of a household is computed to be 0.62. These facts suggest that the number of domestic animals of a household depends on the working population of the household to some extent. It is well known that keeping a herd of pigs demands much care,

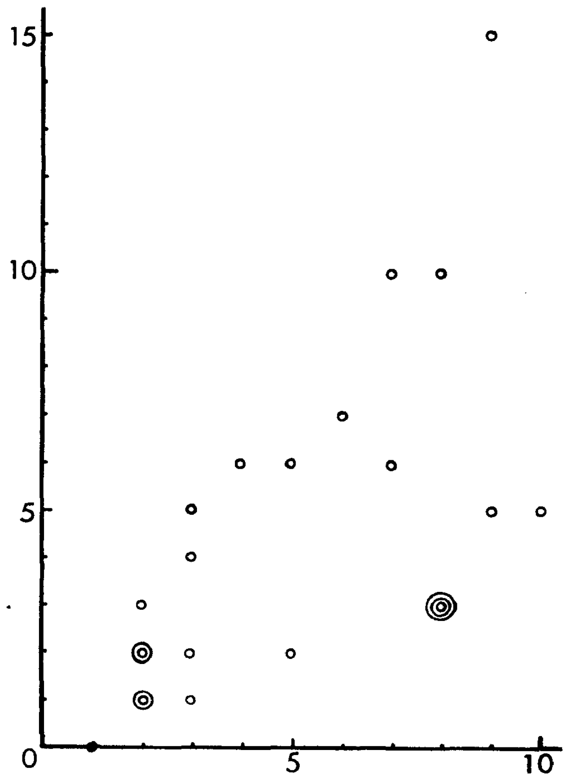


Figure Relationship, at Mae Tho Yang Village, between the number of pigs per household (ordinate) and the number of household members above nine years of age (abscissa). Correlation coefficient $r_1=0.61$; $n=23$.

while a *laissez-faire* policy is to all appearances adopted usually for carabaos or cows. In fact, however, keeping a herd of carabaos and/or cows may also demands much care. The man of House no. 27, whose wife had died, said that his household could not keep a pig owing to the deficiency of woman labor. Thus, at the Karen village, the care of pigs seems to be somewhat related with the woman labor of a household. The correlation coefficient (r_3) between the number of women above nine years of age and that of the pigs of a household is computed to be 0.46.

From Table 7, the total numbers of pigs and carabaos kept by the village as a whole are estimated at 120 and 90 heads, respectively. The estimation of animals killed or sold in a year is not easy. Nevertheless, pigs (except for unweaned piglets) are roughly estimated to have been killed or sold by 50 and 20 heads, respectively, at the whole village during the one-year period between April 1973 and April 1974. On the other hand, about ten carabaos are estimated to have been sold and no cows were sold during the one-year period stated above. Carabaos and cows are rarely slaughtered by Karen people themselves except on unusual ritual occasions, as cited by Iijima [1971: 181] and stated by Kunstadter [1978: 102].

A large amount of rice is consumed by the herd of pigs. The estimation of the rice consumption per head was also quite difficult, but the consumption was determined by asking the villagers. A pig seems to be fed 100–150 kg of unhusked rice per year. In order to maintain 120 pigs and, in addition, to kill and sell 70 head in a year, the feed for a little more than 150 head would be required throughout the period on the supposition that there were no pigs which were either killed or sold. Thus, nearly 20 metric tons of unhusked rice is estimated to be consumed annually by the herd of pigs at the whole village. Pigs are very important as the sacrificial animals to the Karen's gods. Ideally, any family expects to kill at least four head of pigs per year for the purpose of fully gratifying the gods. In order to slaughter four pigs per year, a household must keep at least five. If possible, ten head should be kept. However, only one third of the households there maintained that minimum level desired by the villagers (Table 7). Furthermore, most of those "well off" families do not, in fact, slaughter four head of pigs annually. Their potential demand for pigs is great. As has been stated above, at the harvest of 1973, the rice surplus above the base subsistence level was expected to be somewhat larger than usual. As a result, the people said that they would increase their herd of pigs. Therefore, the rice consumption by the pigs at the whole village would considerably exceed 20 metric tons in 1974 although I could not verify this estimation. Thus, about 40 percent of the surplus above the base subsistence level seems to be consumed by pigs in usual years.

In a few months after the harvest of 1973, seven or eight metric tons of unhusked rice was sold and taken away from the village. This amount was also larger than usual years by a few metric tons. Five households (House nos. 2, 11, 21, 22 and 24) sold rice. Inasmuch as the villagers do not usually sell rice on a large scale in a busy season, the foregoing estimate is considered to be nearly the total annual sale until the harvest of 1974. Thus, when a balance sheet concerning the rice produced there in 1973 is made at this stage, nearly 20 metric tons of unhusked rice remains as the temporary residual. A small quantity of this temporary residual would be consumed by chickens and pet animals. Moreover, although I am not sure, a considerable quantity would be taken away to meet the debts of some inhabitants and consumed by visitors.[3] Finally, a certain quantity of rice would be reserved as the true residual for the years of bad harvest.

As for gathering, hunting and fishing, the situation of my survey village is mostly similar to that described by Kunstadter [1978: 105–107]. Gathering wild vegetables is very important in respect of vitamin, mineral and flavor sources for the inhabitants. Men have lots of fun in fishing and hunting. However, both fishing and hunting seem to add only a trifling amount of animal protein to their diets. In a year, at most only a few men have the luck to shoot wild animals such as porcupines. Their dogs are not competent in pursuing game at all. I have never seen the inhabitants there systematically fishing. No attempt was made to introduce domestic fish. Encountering grasshoppers, tortoises, frogs and so forth, they make efforts to catch those animals. Such activities are not systematic, but sporadic.

Discussion

As has been already explained, without the help of minor workers including old people, an adult at my survey village can manage slightly more than 0.6 ha (excluding unavailable parts) of swidden.

3) The amount of direct tax paid in money may be left out of consideration.

On the basis of this theory, a model can be framed as follows: First of all, let us imagine a nuclear family which consists of a couple and two small children who cannot yet help their parents. The village in question had actually two such families when I was there, as shown in Table 1, but the model with which we are now concerned is not based on those real cases at all. Then, assume that this imaginary couple manages 1.2 ha of swidden excluding unavailable plots, but owns no wet paddy field. In an average year, the couple can expect to obtain 1250 kg of unhusked rice from their swidden. Of this quantity of rice, 110 kg has to be reserved as seed for the following year's production. The couple will consume 760 kg before the next harvest. In consequence, the residual is 380 kg. This simple calculation suggests that this fictitious household can keep no surplus above the base subsistence level if their two children belong to the age group 5–9. In fact, however, domestic rice consumption should be considered flexible corresponding to actual situations. Nevertheless, this above-stated model elucidates that swidden farming without profitable cash crops has only a little ability to provide a household with the surplus above the base subsistence level.

The swiddens of my survey village as a whole were estimated to produce 65–70 metric tons of unhusked rice in usual years. On the other hand, the base consumption and the amount of the reserved seed for swiddens are calculated to be slightly more than 60 metric tons in total. These estimates indicate that the swiddens produce a surplus equal to approximately 10 percent of the total rice production at swiddens. If that village had no wet paddy fields, most of this surplus would have to be reserved for a year of bad harvest. Thus, the conclusion from the above-stated model can apply well to the village as a whole. As regards respective households, however, exceptional cases can be found due to the conditions peculiar to each. In particular, a family which has no small child and holds some minor workers including old people is in a favorable situation because the limiting factor of swidden farming there is weeding which a minor worker can perform fairly well. Izikowitz [1951: 291] states roughly similar circumstances at Lamet villages in Laos. Such a family as House no. 7 (Table 1) can manage a vast area of swidden in literal kinship co-operation with the other families, House nos. 8 and 9. One of the reasons for the fairly clear correlation shown in the figure in the preceding page is considered to be that a family with many working members in proportion to its total size can comparatively easily produce a considerable amount of rice surplus above the base subsistence level.

With reference to a type of subsistence economy similar to that dealt with here, quantitative data comparable with the foregoing could be obtained by Hinton [1978] and Kunstadter [1978] at Karen (both Pwo and Skaw) and Lua' villages in the hilly region of Northern Thailand. At one of Hinton's survey villages (Pwo

Karen tribe), partly because the mean area of swidden per worker there is much smaller than the corresponding area at mine, the rice production of the village as a whole can hardly provide a surplus above the base subsistence level, while the rice yield at a unit area of swidden is evaluated to be considerably higher than at mine [Hinton 1978: 194]. The seed productivity at the swiddens of his survey village is also more favorable than at mine, partly because the amount of seeds broadcast onto a definite area of swidden of the former village is much less than that of the latter [Hinton 1978: 194]. At his survey village, the total area of terraced wet fields is very small, that is, only 0.97 ha against 118 persons [Hinton 1978: 194]. Inasmuch as his survey villages are relatively near to Mae Sariang Town, "Many who have a rice deficit are compelled to seek cash employment in the lowlands" [Hinton 1978: 195].

On the other hand, according to the data of Kunstadter [1978: 110] concerning Lua' and Skaw Karen villages, the mean areas per worker of swiddens at both of his survey villages are somewhat smaller than the corresponding area at mine, and the total area of wet paddy fields there is much smaller than the total area of the wet fields at mine. The reason why three complete weedings at the swiddens of his survey village are usually possible is considered to be that the areas of swiddens and wet fields are not very large there. Generally speaking, both of his survey villages also seem poorer than mine though the Lua' villagers take a surprisingly great amount of rice every day. His quantitative data, too, certainly confirm the hypothesis that the rice production at a swidden hardly exceeds the quantity necessary for the physical maintenance of a worker and the base consumption of only one dependant. At those villages, the mean numbers of pigs kept per household are considerably less than the corresponding number at my survey village. This probably indicates that average surplus above the base subsistence level per household at those villages is less than the counterpart at my survey village. In addition, the estimated level of rice consumption for routine meals per capita at my survey village is considerably higher than the average of all the comparable values including Walker's [Walker 1976: 182]. This implies that the rice surplus there is not brought about by the control of the appetite of the villagers.

A huge amount of rice surplus above the base subsistence level at my survey village is, without doubt, chiefly brought about by a comparatively large area of wet paddy fields. It should be noted that the rice surplus above the base subsistence level there is roughly equal to the total yield from irrigated paddy fields. As has been already pointed out, if the mode of labor input is carefully planned, most of the activities at swiddens and at wet fields do not fall on the same days. That is to say, for the farmers fundamentally based on swidden farming, the cultivation of rice at wet fields hardly reduces the production at swiddens, but rather is additive to swidden farming. This fact should be regarded as very significant for the development of agriculture in circumstances similar to those of my survey village.

As shown in Table 6, one hectare of swidden at my survey village produced, on average, 1.16 metric tons of unhusked rice in 1973. This amount of rice would be divided into 860 kg of husked rice edible to the inhabitants and 300 kg of husk plus bran edible to chickens. Eight-hundred and sixty kilograms of husked rice contains approximately 2.9×10^6 kcal of combustion energy according to the calculation based on Standard Tables of Food Composition[4)] [Japan Nutritionist Association 1964: 19]. On the other hand, the labor input (net energy expenditure) onto one ha of swidden for rice production has been estimated at 2.0×10^5 kcal per year though possibly underestimated somewhat. In consequence, if the calories of the edible portions of chickens which feed on the rice bran are not taken into account, the ratio between obtainable energy and expended energy for the rice production at the swidden of my survey village is calculated to be not more than 14.5.

Similar value of the rice production at wet paddy fields can be calculated if Moerman's data [1968: 171], which were obtained at the traditionally treated paddy fields of a Tai-Lue village in another hilly region of Northern Thailand, are applied to the labor input onto the wet fields of my survey village. According to his data [Moerman 1968: 171], the labor input onto one ha of wet paddy field per year (one harvest time) is 99 man-days. If the average number of work hours (excluding resting times) in a day is tentatively assumed to be six, 99 man-days may be interpreted as approximately 600 man-hours. As a result of calculation, concerning the wet fields of my survey village, the energetic ratio similar to the foregoing figure for swiddens is estimated at 36.1. Although this value is not very accurate, it seems certain that the labor productivity of rice swiddens at my survey village will be evaluated to be far less than 50 percent as compared with that of irrigated paddy fields.

As has been already stated, at rice swiddens of my survey village, maize and other subsidiary crops are grown together with rice, so that the additive energy output should be taken into account besides the energy of yielded rice. Of course, the labor inputs for the production of those crops would also be required, but these were impossible to ascertain. In any case, if the yields of those crops at swiddens were taken into account, the value of the labor productivity of all crops would increase only slightly from the figure calculated above, since the energy expenditure for weeding was taken into account when the value of rice production was calculated. Thus, the figure 14.5 would hardly improve.

Norman [1978: 359] has computed

4) Caloric values used in nutritional science are usually slightly less than those measured by bomb calorimeter, because man cannot completely oxidize protein in his body.

similar values on the basis of some data of Clark and Haswell [1970] concerning rainfed hoe cultivation in the tropics of Africa. When the above-shown figures concerning the rice production at swiddens and wet fields are compared with those of cereals in his table [Norman 1978: 359], the figure of swiddens (14.5) belongs to the lower group, whereas that of wet fields is almost the highest of all. This fact seems to support his suggestion [Norman 1978: 360], "Collectively, the figures hint that human energy input per hectare may on average be somewhat higher for shifting cultivation than for more intensive cropping systems,..." A number of western writers emphasize the favorableness of swidden agriculture with reference to labor productivity. Gourou [1969: Ch. 9] cites some interesting examples which support this view. Furthermore, particularly since Boserup's theory was published in 1965, the view has become widely popular. It certainly has irrefutable basis in so far as most areas of the world are concerned. Her theory itself is very excellent and attractive and seems widely applicable to real facts. As regards rice production in Southeast Asia, however, due partly to the adoption of plows with the help of carabao power, the annual cultivation at irrigated wet fields should be considered to surpass decidedly short-fallow upland cultivation, to which the farming at the swiddens of my survey village belongs, or even long-fallow upland cultivation in labor productivity in many cases because the cultivation at wet fields is not always very intensive in spite of no fallow period. A statement similar to this opinion is set forth also in a textbook [Harris 1975: 249]. The famous data of Gourou [1940: 240] as to the Tonkinese Delta indicate surprisingly intensive labor input. However, he himself states that his survey area was in a situation that marginal labor productivity appeared to be exactly zero when he was engaged in his field research [Gourou 1956: 342–343]. At the same time, he cites the successful examples of inundated paddy fields at the valley bottoms in hilly regions of Madagascar [Gourou 1956: 340]. Certainly, the appropriate management of irrigation systems in a vast plain requires much labor input, as Boserup [1965: 39–40] points out. By contrast, wet paddy fields in a hilly region can be considered to be endowed with especially favorable conditions regarding labor productivity if the general technology level is low, since they do not need much input for the construction, maintenance and operation of irrigation systems [Nakano 1979]. The economy of Karen people in Thailand was not based originally on rice production at irrigated fields, but mainly on swidden agriculture [Iijima 1971: 121–122]. When they began to cultivate wet paddy fields besides farming swiddens, their total labor input was certainly multiplied, whereas average labor productivity is considered to have improved significantly without any doubt even if the additive labor input for keeping carabaos is taken into account. It is unthinkable that population pressure forced

Karen farmers to begin rice cultivation at irrigated fields and, at the same time, to adopt carabao-drawn plows. Attention should be paid to the fact that paddy is a biologically extraordinary plant which can grow vigorously in the conditions of temporary swamp, where most weeds cannot compete with paddy owing to the lack of oxygen in the soil. As a result, the intensive labor input for weeding at inundated fields after transplanting seedlings is not always necessary, although weeding manually after the transplantation is taken as a matter of course in many regions with high population density such as Java [Geertz 1963: 35], and Japan in the old days.

In various senses, pigs are very important to the inhabitants of my survey village. Pork gratifies the gods and the sense of taste of the people. Sowing the swidden with paddy seeds is a communal event there. For sowing the swidden of a household, at least one person of each household has to take part in the communal work. At lunch on the sowing day, the host family has to provide pork curry. Similarly, on the days of transplanting rice seedlings into inundated fields, and of harvesting both at swiddens and at irrigated fields, if possible, the villagers wish to take pork though these works are not communal. Only two families, namely, House nos. 1 and 2, can actually satisfy their desire every year. These two households own comparatively large areas of wet paddy fields. Even at the occasion of sowing their swiddens, some families are obliged to buy pork from merchants to provide lunch for the participants. As has been already stated, the number of pigs slaughtered at the village in a usual year is estimated at about 50. In addition, a certain quantity of pork is bought from merchants. Thus, the total consumption of pork by the inhabitants (excluding the school teachers) in a year is estimated to be at most 2 metric tons. When it is assumed to be 2 tons, which contains approximately 300 kg of protein [Japan Nutritionist Association 1964: 55], the daily mean intake per capita is 30 grams (g). In fact, an adult is considered to take much more than 30 g of pork (including pig organs), which contains roughly 100 kcal of energy and 4.5 g of protein [Japan Nutritionist Association 1964: 55]. However, the villagers take pork only on special occasions, as has been already mentioned; hence the nutritional significance of pork in their diets seems to be almost negligible on most days although other aspects of significance cannot be ignored. Nonetheless, approximately 20 percent of food (including maize) produced there is consumed by pigs. This fact should be regarded as remarkable. Rationally, it might be better if the peasants sold their surplus rice and bought pork on the occasions which require it. At the present time, pork can be always bought from merchants. In fact, I occasionally heard that some Christian villages, which need not keep a large herd of pigs for religious purposes, had much more surplus rice to sell than before they became Christians.

Still, pigs at my survey village seem to fill the role of shock absorber against a poor rice harvest. The yield at swiddens fluctuates greatly year by year, as is well known. Then, after a poor harvest, if the yield is not terribly low, the villagers can tide themselves over the adverse conditions by slaughtering many pigs.

Because Karen people rarely use carabaos as ritual sacrifice, the villagers themselves do not usually eat carabao meat or organs, except when they sell their animals to butchers, who give the sellers a small quantity of meat and/or organs after the carabaos are slaughtered on the spot. Therefore, unless their carabaos die of disease or accidents, only a few people have the opportunity to eat such meat or organs in a year. Thus, their carabaos have no nutritional significance in their routine diets. Cows are similarly treated, so that they also have no nutritional significance.

Chickens are often used as ritual sacrifice instead of pigs. Most of the chickens in the hilly region are very lean. Unlike pork, the meat and/or organs of chickens are not usually consumed together with other families. Chickens are very often sold to merchants in exchange for dried fish, clothes, rubber sandals, medicines, tobacco, other daily necessities and opium. No quantitative data as to the amount of chicken meat and eggs taken by inhabitants themselves could be obtained. However, it should be noted that most of the bran produced at the time of husking rice for their routine meals is ingested by chickens. On the basis of my own measurement of the rice grains there,[5] the total quantity of such bran is estimated at 6.6 metric tons annually, which contains 0.87 ton of protein [Japan Nutritionist Association 1964: 20]. Using this estimation, at the whole village, much more than 100 kg of protein seems to be supplied annually to the villagers by chickens even if those for sale are excluded.

In conclusion, usually both energy and protein are mostly derived, at my survey village, from rice without any doubt. The husked rice which the villagers take is very rich in protein. According to my own chemical analysis, their husked rice contains nearly eight percent of protein, for it is not much polished. As has been already stated, mean consumption of unhusked rice per capita is estimated at 300 kg annually, which is changed, on average, into 220 kg of husked rice by means of their husking mills. This value means 600 g per day. This amount of husked rice contains slightly more than 2000 kcal of energy [Japan Nutritionist Association 1964: 19] and 48 g of protein (using the result of my own analysis). A male adult is estimated to ingest daily more than 2800 kcal of energy and 68g of protein from rice. Thus, if we are allowed to consider the digestibility of their husked rice to be not much worse than that of polished rice, the nutritional state there cannot be regarded as terrible at all though several families cannot afford to supply themselves with

5) unhusked rice (100%)→ husked rice (74%) + bran (12%) + husk (14%)

a sufficient amount of rice.

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References

Boserup, Ester. 1965. *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure.* London: Allen and Unwin.

Clark, C.; and Haswell, Margaret. 1970. *The Economics of Subsistence Agriculture.* Fourth Edition. London: MacMillan.

Conklin, H. C. 1957. *Hanunóo Agriculture: A Report on an Integral System of Shifting Cultivation in the Philippines.* FAO Forestry Development Paper, No. 12. Rome: FAO.

Freeman, D. 1970. *Report on the Iban.* London School of Economics Monographs of Social Anthropology, No. 41. New York: Humanities Press Inc.

Geertz, C. 1963. *Agricultural Involution.* Berkeley and Los Angeles: The University of California Press.

Gourou, P. 1940. *L'Utilisation du Sol en Indochine Française.* Paris: D'Études de Politique Étrangère.

———. 1956. The Quality of Land Use of Tropical Cultivators. In *Man's Role in Changing the Face of the Earth,* edited by C. O. Sauer, M. Bates and L. Munford, pp. 336–349. Chicago: The University of Chicago Press.

———. 1969. *Les Pays Tropicaux: Principes d'une géographie humanine et économique.* Fifth Edition. Paris: Presses Univ. France. (Translated by S. Yamamoto *et al.* into Japanese in 1971. Tokyo: Asakura Shoten.)

Harris, M. 1975. *Culture, People, Nature: An Introduction to General Anthropology.* Second Edition. New York, Hagerstown, San Francisco and London: Thomas Y. Crowell.

Hinton, P. 1969. *The Pwo Karen of Northern Thailand: A Preliminary Report.* Chiang Mai: Tribal Research Centre. (Mimeographed)

———. 1978. Declining Production among Sedentary Swidden Cultivators: The Case of the Pwo Karen. In *Farmers in the Forest: Economic Development and Marginal Agriculture in Northern Thailand,* edited by P. Kunstadter, E. C. Chapman and Sanga Sabhasri, pp. 185–198. An East-West Center Book. Honolulu: The University of Hawaii.

Iijima, S. 1971. *Karen-zoku no Shakai·Bunka Henyo* [Social and Cultural Change among the Karens] — *Tai-koku ni okeru Kokumin Keisei no Teihen* [A Grass-roots Movement of Nation Building in Thailand]. Tokyo: Sobun-sha.

Izikowitz, K. G. 1951. *Lamet: Hill Peasants in French Indochina.* Göteborg: Ethnografiska Museet.

Japan Nutritionist Association, ed. 1964. *Standard Tables of Food Composition.* Third Revised Edition. Tokyo: Dai-ichi Pub. Co.

Kunstadter, P. 1978. Subsistence Agricultural Economics of Lua' and Karen Hill Farmers, Mae Sariang District, Northern Thailand. In *Farmers in the Forest: Economic Development and Marginal Agriculture in Northern Thailand,* edited by P. Kunstadter, E. C. Chapman and Sanga Sabhasri, pp. 74–133. An East-West Center Book. Honolulu: The University of Hawaii.

Moerman, M. 1968. *Agricultural Change and Peasant Choice in a Thai Village.* Berkeley and Los Angeles: The University of California Press.

Nakano, K. 1978. An Ecological Study of Swidden Agriculture at a Village in Northern Thailand. *Tonan Ajia Kenkyu* [South East Asian Studies] 16(3): 411–446.

———. 1979. For the Rational Land-use Patterns in the Hilly Regions of the Tropics. *Proceedings of the 5th International Symposium of*

Tropical Ecology — Ecology and Development — Kuala Lumpur, Malaysia, April 16–21, 1979. (In Press)

Norman, M. J. T. 1978. Energy Inputs and Outputs of Subsistence Cropping Systems in the Tropics. *Agro-Ecosystems* 4(3): 355–366.

Rappaport, R. A. 1971. The Flow of Energy in an Agricultural Society. *Sci. Am.* 224(3): 116–132.

Walker, A. R. 1976. The Swidden Economy of a Lahu Nyi (Red Lahu) Village Community in North Thailand. *Folk* 18: 145–188.

Plate 2 A married woman slashing the undergrowth of a secondary forest in preparing her household's swidden. February, 1973.

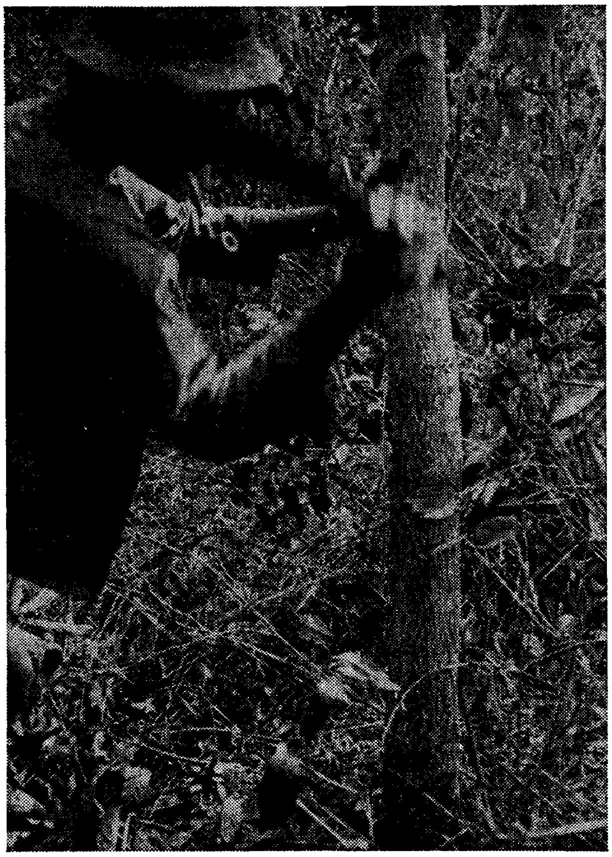

Plate 1 A man felling a young tree in preparing a swidden. February, 1973.

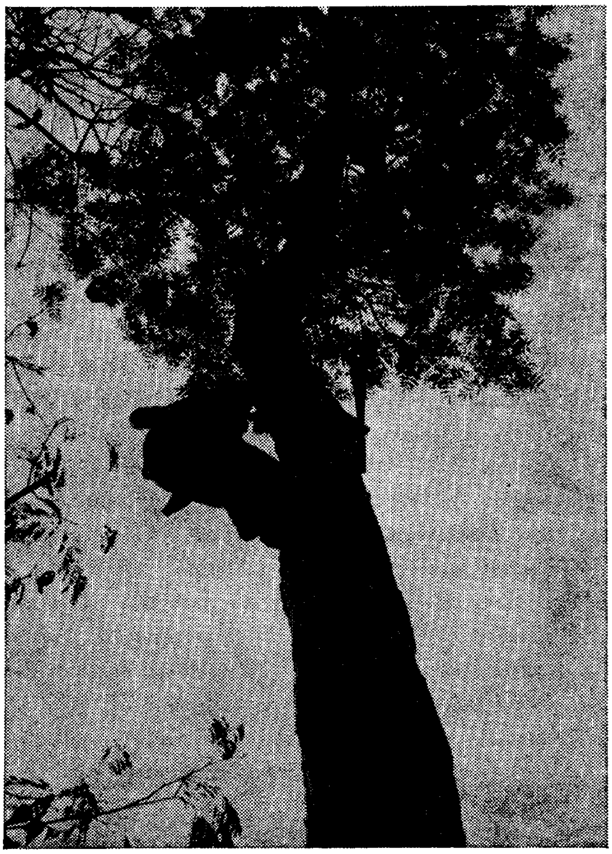

Plate 3 A young man about to cut the branches off a big tree on his household's swidden site. February, 1973.

Plate 4 A man applying a torch to burn the felled and dried vegetation. March, 1973.

Plate 5 Villagers sowing rice in a swidden. This is a communal event. April, 1974.

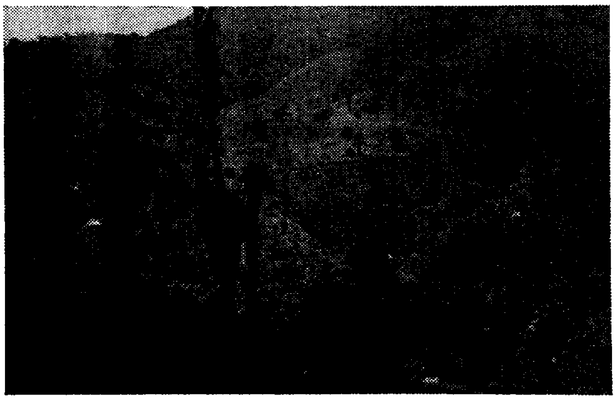

Plate 6 A view of swiddens and terraced paddy fields. Abandoned fields of Meo people can be seen in the distance. Note that the big trees in swiddens are sprouting again several months after the destructive fire. July, 1973.

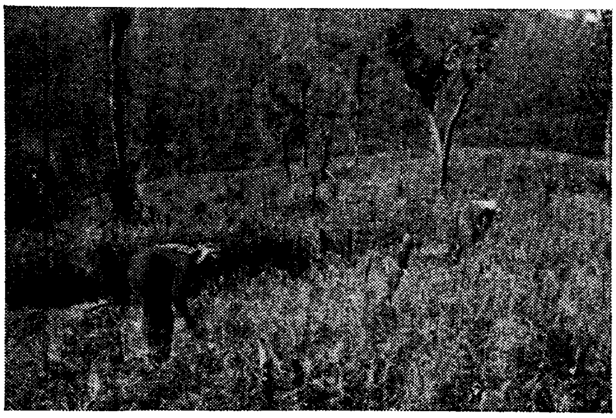

Plate 7 Two swiddeners reaping mature rice plants with sickles. October, 1973.

Plate 8 Three swiddeners threshing rice in a swidden. The wife of the household working this swidden beats a bundle of mature rice plants against a bamboo plait on the ground to separate most grains from the ears. The young male helpers thrash the residual grains with L-shaped sticks. October, 1972.